

## Material Defects and Electrical Power Switching in Semiconductors

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Wide bandgap (WBG) semiconductor power switching devices, especially those made on silicon carbide (SiC) and gallium nitride (GaN), promise transformative advances in electrical power switching systems because of superior electrical and thermal properties of these materials compared to the semiconductor silicon [1]. However, the progress has been slow despite intense scientific and industrial development. Both SiC and GaN semiconductors contain a high density of crystal defects and the role of defects on the performance and reliability of electrical power switching devices operating under extreme environment is not clear. Using synchrotron white beam X-ray topography (SWBXT), it is shown that the breakdown mechanism in 4H-SiC is initiated at the threading screw dislocations present in the high field regions of a power diode. To avoid this phenomenon from occurring, commercial 4H-SiC high-voltage diodes are rated for punch-through leakage currents rather than for avalanche breakdown condition. Thus, crystal defects in 4H-SiC present a major roadblock for improving the performance and reliability of power switching devices.

[1] K. Shenai et al, "Current status and emerging trends in wide bandgap (WBG) semiconductor power devices," *ECS J. Solid State Sci. and Tech.* **2**(8), N3055-N3063, Jul. 2013.